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GEARKSUTITE FROM VIRGINIA.[1]

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INTRODUCTION

A sample of a white clay-like material sent in by Mr. Noah George of Hot Springs, Virginia, for identification was found to be the rare mineral gearksutite, a hydrous fluoride of calcium and aluminum. The locality, about midway between Hot Springs and Warm Springs, Va., on the main highway, was later visited by the writer in the company of Mr. George and a more extensive collection of material was made, which is now deposited in the U. S. National Museum, at Washington, D. C. Gearksutite had previously been found only in Greenland and Colorado.

GEOLOGICAL OCCURRENCE

Gearksutite occurs in a clay bed in the Trenton limestone of Ordovican age. This clay bed is about 500 ft. above the limestone (Lowville) from which the hot springs of the district issue. The thickness of this bed of clay was not accurately determined because of the nature of the exposure, but it appears to be less then 3 feet, perhaps nearer one foot.

Most of the clay is brown, but on digging a small trench through it, several masses of a white greasy appearing clay were encountered. This light colored clay has the appearance of bentonite—however it contains abundant angular grains of detrital quartz and also fails to show, in thin section, the volcanic-ash structure typical of most bentonites. Since its physical properties, color, and swelling in water, are like those of true bentonites and also this same geologic horizon has produced some material which was determined as a bentonite this white clay in this paper will be referred to as a bentonite. The volcanic-ash structure is commonly destroyed by weathering processes, hence its absence is not conclusive evidence that this clay is not a bentonite.

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[1] Published by permission of the Director, U. S. Geological Survey.

The gearksutite occurs in this white clay as rounded masses of snowy white material, some of which measures about 5 cm. in diameter, though most of the nodules are much smaller. It also appears as an efflorescence in the seams and on the surface of the clay. Such an occurrence suggests that it has been deposited from a solution, as the associated gypsum has certainly been formed in such a manner. The only other mineral noticeable in any quantity is iron pyrites and this has undergone partial alteration to limonite. No other fluorine mineral was found.

Two occurrences of gearksutite in the United States, both in Colorado, have been previously noted and the first occurrence was described by Cross and Hillebrand,[2] who stated: "Among the minerals from St. Peter's Dome gearksutite is quite abundant. It is not formed from other minerals by molecular replacement, but is deposited from solution in cavities upon fresh crystals of pachnolite, etc. The smaller cavities are sometimes filled by it, and on the contact with the quartz it is especially developed."

A second deposit was later found at Wagon Wheel Gap, Colorado, and described by Larsen and Wells,[3] who stated: "The vein is entirely in tertiary volcanic rocks made up of lava flows and tuff beds of rhyolite and quartz latite, with subordinate andesite." "The lower tunnel of the mine, whose portal is about 100 ft. east of one of the hot springs, follows the vein and some distance from the portal it passes through a large body of soft, highly altered rock, which carries very abundant balls up to several inches across, of snow white, powdery gearksutite. These balls are easily separated from the altered rock and resemble a fragile chalk or kaolinite."

CHEMICAL COMPOSITION.

A ball of gearksutite, from the Virginia locality was gently crushed and the powder passed through a sixty mesh screen. Only a portion finer than this mesh was used for the analysis. Further purification was obtained by washing the powder in a tall cylinder, the gearksutite, being very light of weight, remains suspended in solution longer than the clay, and by siphoning off the suspended material and repeating this water treatment, three times, a sample was obtained.

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[2] *U. S. Geol. Survey, Bull.* **20,** p. 59, 1885.

[3] *Proc. Nat. Academy Scienes,* vol. **2,** p. 360, 1916.

The material consists of extremely minute matted fibers, with a mean index of about 1.45.

ANALYSIS AND RATIOS OF GEARKSUTITE FROM VIRGINIA

Analysis		Ratios	
Insol.	0.96		
Al	15.09		.559
Ca	22.15	.552	.562
Na	0.20	.009	
K	0.05	.001	
O	5.42		.339
H_2O	15.52		.862
F[a]	40.20		2.116
	99.59		

[a] Direct determination made by Mr. H. W. V. Willems, a visiting chemist in the U. S. Geological Survey.

The ratios are treated in the same manner as given by Hillebrand, namely, subtracting from the ratio for water an amount equal to that for oxygen which is necessary to form the hydroxyl. The ratios then obtained are:

READJUSTED RATIOS OF THE ANALYSIS

Al	.559		1.00	1
Ca	.562		1.01	1
H_2O	.523		0.94	1
(OH)	.678	2.794	5.00	5
F	2.116			

These ratios agree with the simple formula already established, namely, $Ca \cdot Al \cdot 5(F,OH) \cdot H_2O$. In this material the fluorine and hydroxyl combined with the aluminum are in the ratio of 99:68 (nearly 3:2) instead of 2:1 as found by Hillebrand.

The fluorine percentage in this Virginia occurrence is lower than in any of the other analyzed samples of gearksutite. It is commonly considered that the fluorine and hydroxyl are isomorphous. If this be true then it is remarkable that in the published analyses of this mineral, from four different localities, the percentages of both fluorine and water are unusually constant.

PERCENTAGES OF FLUORINE AND WATER IN GEARKSUTITE.

Analyst	Hagemann[a]	Hillebrand[c]	Lindström[d]	Wells[e]	Henderson	Calculated[f]
Locality	Greenland	Colorado	Greenland	Colorado	Virginia	
F	41.18	42.07	41.81	41.00	40.20	42.9
H_2O	16.83[b]	15.46	15.03	15.20	15.52	15.1

[a] Dana, System of Mineralogy, 5th ed., p. 130.

[b] See following text remarks about Hagemann's analysis. The value here given has been recalculated as explained below.

[c] *U. S. Geol. Survey, Bull.* **20,** p. 59, 1885.

[d] *Geol. För. Förh.*, vol. **7,** p. 687, 1885.

[e] *Proc. Nat. Academy Sciences,* vol. **2,** p. 360, 1916.

[f] As given by Wells, based on a 2:1 ratio of F to (OH) combined with the aluminum.

The determinations of fluorine and water as given by Hagemann and Flight[4] were considered to be incorrect by Hillebrand. If the fluorine determination made by Hagemann be taken as correct, his results can be recalculated for water as follows: His summation without water and without the oxygen addition is 78.41 per cent. The quantity of oxygen added (based on the percentage of Al) is 4.76 per cent, which brings the summation (without water) to 83.17 per cent. Determining the water by difference gives 16.83 per cent for water. Flight determined only the bases and assumed that they were fully combined with fluorine, thus obtaining by difference an erroneous percentage of water.

The recalculated values given for Hagemann's analysis are of uncertain value yet they agree rather well with the others. The remaining determinations given show a remarkable constancy for the percentage of fluorine and hydroxyl and agree rather closely with the 2:1 ratio. It would seem that such a series of determinations made upon gearksutite from four separate places would not be in such close agreement with each other if the fluorine and hydroxyl are isomorphous with each other.

Determinations of water (by loss) at different temperatures gave the following results:

Temperature C.	Per cent loss	Total loss
250°	0.62	0.62
250–275	1.18	1.80
275–300	1.02	2.82
300–350	10.55	13.37

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[4] *Jour. Chem. Soc.*, vol. **43,** p. 140, 1883.

These results agree with those of Hillebrand in showing that gearksutite suffers practically no loss below 200°. Hillebrand obtained a considerable loss at 250°–300°, whereas the results found on the mineral from Virginia indicate that the first large loss takes place above 300°.

Origin of the Virginia Gearksutite

This mineral has doubtless been deposited from circulating waters, and an analysis of water from different hot springs of this district, shows a small amount of calcium fluoride in solution. The hot springs carry larger quantities than the cooler springs perhaps due to the fact that the water of hot springs circulate at greater depths and naturally becones heated which increases the solubility of calcium fluoride, also the water issuing from hot springs has been in contact with the rocks longer, and so more calcium fluoride has been dissolved.

The source of the fluorine is undoubtedly in the limestone and possibly from fossils contained therein.

The circulating underground waters carrying the calcium fluoride in solution could migrate to the bentonite bed and here a reaction would take place whereby gearksutite is formed, the aluminum being supplied by the clay bed and the calcium and the fluorine by the ground waters.

The above explanation of the origin would indicate that gearksutite should be a rather common mineral in the clay beds of this district. This, however, does not seem to be true as beds of clay were found in this same geologic horizon that were apparently free from gearksutite. The fact that it is a white, clay-like mineral and can be readily overlooked may account for the reason that it has not been more widely found. Again the hot springs issue from a very restricted outlet and the present location of the gearksutite in the clay may be near an extinct hot spring channel.

CELESTITE IN CENTRAL ONTARIO

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Strontium minerals occur in several different veins in central Ontario; most commonly as gangue minerals but occasionally in sufficient quantity to have economic possibilities. At Galetta, west of the City of Ottawa, barytocelestite, $5BaSO_4 \cdot SrSO_4$, is associated with calcite in a vein that is being worked for lead.[1] Well formed crystals of celestite are found at the old Frontenac lead mine north of Kingston. Tabular crystals and fibrous aggregates up to several feet in diameter occur in veins associated with fluorspar in the Madoc district, north of Belleville. Two other localities for celestite are at Lyndhurst on the Brockville-Westport branch of the Canadian National Railway and in the neighborhood of Verona, north of Kingston.

Of a slightly different type is the celestite found near Calabogie[2] on the Kingston-Pembroke branch of the Canadian Pacific Railway. It takes the form of slab-like masses enclosed in brown dolomite and it seems probable from field evidence that the strontium-bearing solutions were ascending and had their origin in an intrusive diabase dike. The larger masses of celestite have a vein-like character and it is possible that the deposit assumes, in depth, true vein form.

In the vicinity of Kingston celestite occurs in segregations or nodular masses in the Paleozoic limestone, radially fibrous aggregates being common in addition to the tabular crystal form. The limestone belongs to the Black River group. At Kingston it is very fine grained and compact; in places almost lithographic in quality. The celestite nodules are nowhere connected with any veins in this locality, and this is suggestive of Uglow's conclusion[3] that the calcite-barite-fluorite-galena veins of this district were formed by the mingling of meteoric and magmatic waters. Strontium would thus be leached from the sediments and added to the ground water circulation.

The present investigation was undertaken mainly to determine whether the strontium in the limestone is present in forms other than that as celestite in nodules. If it could be shown that strontium occurs as the carbonate or as disseminated celestite in the limestone it would indicate that the strontium found in the vein filling minerals might have come from vadose solutions percolating through the limestone and tend to corroborate the hypothesis that the lead-zinc veins were in part at least due to meteoric waters. The methods employed and the results obtained are here presented.

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[1] E. L. Bruce and Margaret Light, *Am. Mineral.*, Vol. **12**, 1927, p. 396.

[2] H. S. Spence, Barium and Strontium in Canada, *Mines Branch, Dept. of Mines, Ottawa*, p. 80.

[3] W. L. Uglow, *Ont. Bur. Mines*, Vol. **25**, part 2, p. 40.

It is notable that, although strontium sulphate is practically insoluble in acids, it is appreciably soluble in water. Thus a given volume of water will dissolve approximately thirteen times as much $SrSO_4$ as $SrCO_3$, and more than twice as much $SrSO_4$ as $CaCO_3$.

$$\text{100 parts of water will dissolve,}^{4} \quad \begin{cases} .0144 \text{ parts of } SrSO_4 \text{ at } 18°C \\ .0011 \quad \text{“} \quad \text{“} \; SrCO_3 \; \text{“} \; 18°C \\ .0065 \quad \text{“} \quad \text{“} \; CaCO_3 \; \text{“} \; 20°C \end{cases}$$

These figures may be used for the natural substances without serious error. Waters percolating through limestone, however, are more or less carbonated, and this would tend to lessen the solubility of celestite or prevent its solution altogether. An alternative possibility is that the carbonated waters might convert the sulphate to the carbonate, in which form it is quite soluble. (100 parts of CO_2 water dissolve 0.12 parts of $SrCO_3$[4]). This would involve a later change to the sulphate before its deposition in the nodules or in the veins as celestite.

Celestite is prepared for analysis by boiling for an hour or more in a concentrated solution of sodium carbonate. This changes strontium sulphate completely to the carbonate. Barium sulphate is only partly converted to the carbonate even under the most favorable conditions and fusion must be carried out to prepare it for analysis. Celestite is not converted to carbonate in a fusion. In every case a residue was found insoluble in HCl and it was evident that the mineral had not been attacked or only partially decomposed.

There is difficulty also in making a complete reduction of strontium oxalate to oxide, and, even when using the purest sample, results as low as 43 per cent for SrO were obtained. The use of a smaller sample would probably permit of complete reduction but this would lessen the accuracy of the minor constituents to be determined. A satisfactory alternative is to convert the oxalate to sulphate and weigh it as such. Hillebrand does not mention this method but it is noted in other standard quantitative texts.

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[4] Hodgman and Lange, *Handbook of Chem. and Physics*, 13th edition.

A two-gram sample of limestone was taken for analysis and it was found impossible, satisfactorily, to ignite the large oxalate precipitate to oxide. As it was essential to test for strontium, a smaller sample could not be used so that conversion to sulphate was the only alternative.

Although completed analyses have not been made of either celestite or the associated limestone, the following procedure has been tested rather thoroughly and should be applicable where strontium is to be determined in the presence of the common elements associated with strontium.

When a sample is boiled in a concentrated solution of sodium carbonate, calcium, strontium, magnesium, and part of the barium are converted to carbonates, while iron, silica, aluminum and most of the barium are not attacked. Hydrochloric acid dissolves from this residue calcium, strontium, the barium present as carbonate, magnesium, iron and aluminum, leaving silica and barium sulphate undissolved. From this chloride filtrate, in the presence of ammonium chloride, ammonia precipitates iron and aluminum as hydroxides. Calcium and strontium are then separated from barium and magnesium by precipitation in an ammonium oxalate solution. This precipitate is treated with sulphuric acid and the combined sulphates of calcium and strontium are weighed. They are then converted to carbonates in boiling sodium carbonate solution, dissolved in nitric acid, and evaporated to dryness. Calcium is separated from strontium in 1:1 alcohol-ether mixture, the precipitate of calcium being collected in a Gooch crucible and determined as nitrate. The amount of strontium can then be found by difference.

The above is simply an outline of the method employed without details of procedure.

Repeated tests following this method failed to reveal in the limestone any trace of either strontium carbonate or sulphate other than the segregated masses of celestite.

Kraus[5] has described the celestite from an island in Put-in-Bay in Lake Erie and from a study of the surrounding rocks considers that the concentration of celestite is the result of leaching of strontium-bearing sediments. Other localities described from Michigan are of the same type. In these occurrences, however, it is evident that the celestite was originally deposited in small disseminated crystals in the sediments for the leached rock is pitted and distinctly porous.

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[5] E. H. Kraus, *Amer. Jour. Science,* Vol. **19,** 1905, p. 286.

In contrast, the Kingston celestite occurs in nodular masses six inches or more across and not in small disseminated crystals. The celestite nodules give no evidence of having filled cavities, for the crystals are in compact masses, and, as far as examined, have left no interstitial openings. The chemical data obtained show no dissemination of strontium in the limestone although more refined methods of analysis might disclose its presence. There is, therefore, no proof of the secondary nature of the celestite nodules.

In conclusion, it may be said that this investigation does not support Uglow's hypothesis but since the results are negative and no other source of the strontium in the veins has yet been proved, the assumption of a meteoric source for the strontium solutions must still be considered possible.

A STAINING METHOD FOR THE QUANTITATIVE DETERMINATION OF CERTAIN ROCK MINERALS

A. Gabriel and E. P. Cox, *University of Oregon*

Introduction

Speed and accuracy may be increased in the quantitative determination of the more abundant mineral constituents in thin sections or polished surfaces of igneous rocks, or in the sands or grains derived from them, by decomposing the surface of the mineral constituents with hydrofluoric acid, and then very carefully immersing this in a concentrated sodium cobaltinitrite solution. This reagent produces a precipitate of yellow potassium cobaltinitrite on the potash feldspars which clings tenaciously to them. No precipitate is formed on the plagioclases. After this simple treatment the potash feldspars are intensely yellow, quartz is transparent, the plagioclases are white and opaque to transmitted light, the micas remain white or black, depending on the variety, but they can be differentiated by their flat surfaces. The percentages of the minerals can be determined by grain count.

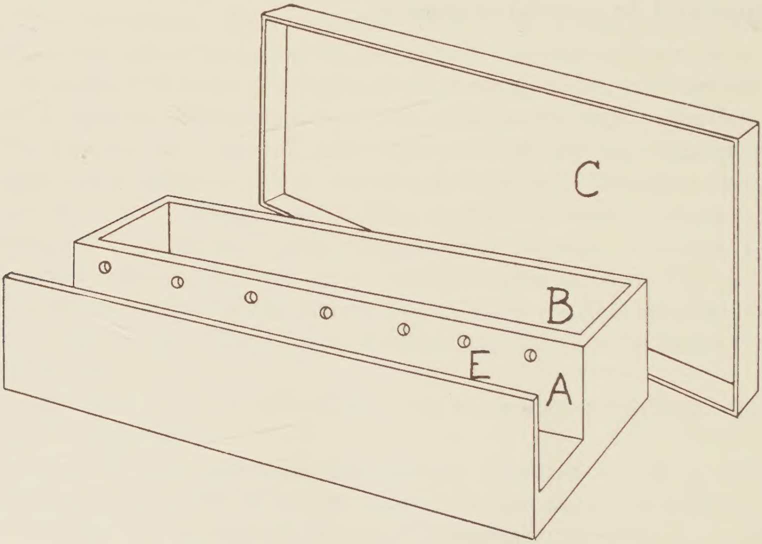

Fig. 1

If the biotite is decomposed by weathering it yields a yellow precipitate and the original black will show through the yellow and give the grain a decided green color. The micas, however, especially muscovite, are not usually decomposed by the treatment.

If desired, the identification of the plagioclases can be further enhanced by the use of a dye such as eosine, which stains them but leaves the potash feldspars predominately yellow.

Apparatus

The treatment with hydrofluoric acid is carried on in a lead casting consisting of an enclosed chamber on one side and an open channel on the other (See A & B, Fig. 1); the whole covered by a lead top.

A number of lead trays (Fig. 2 D) used to carry the grains or specimens to be etched, are made of such a size as to slip easily in the channel (A). Enough trays are made to more than fill the length of the channel, so that the last, on being inserted, will force the first one out. Thus the cover (Fig. 1 C) need not be removed to take trays from the bath and no corrosive fumes escape into the room. A lead bank (Fig. 2 F) is used to cover the ends of the channel during the etching period as a further precaution against escaping fumes.

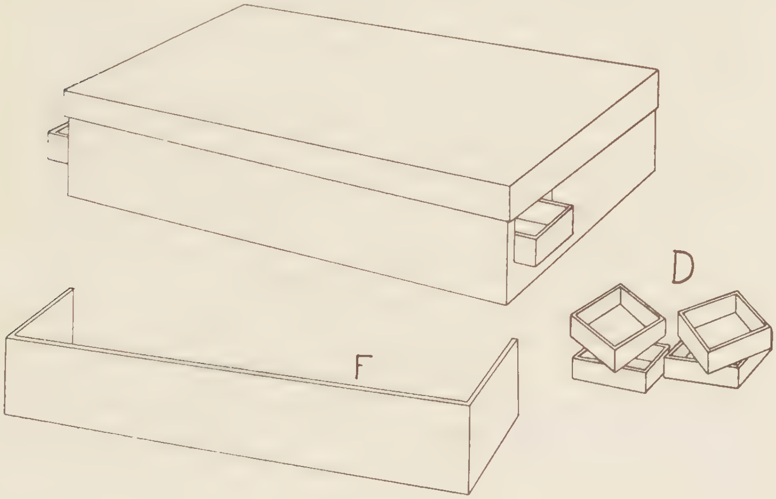

Fig. 2.

The holes in the casting (Fig. 1 E) allow the vapors to pass from B to A and should be large enough to insure a high gas density.

PROCEDURE

The crushed rock or sand sample should pass through a 65 mesh sieve and be caught on a 200 mesh sieve. To reduce the proportion of excessively fine material, the sample should be crushed in the presence of a crystalline sucrose buffer. After crushing the sucrose may be removed by solution in water. The screened sample is well mixed and a representative sample of 0.1 to 0.2 grams is placed, one layer deep, in one of the lead trays (Fig. 2 D). A thick paste of calcium fluoride and sulphuric acid is placed in the channel B, the trays are slid into the lead channel E and exposed to the acid vapors until a faint white coating can be seen on the grain or rock surface. This usually takes about 10 to 12 minutes. A temperature of 60°C to 70°C is maintained throughout the etching period in order to insure a rapid and constant evolution of hydrofluoric acid vapor.

The samples are now transferred to a wide shallow dish and well distributed. A concentrated sodium cobaltinitrite solution is carefully poured over the grains and allowed to remain in contact with them for about one minute. The sodium cobaltinitrite solution can be made by adding 15cc. of glacial acetic acid and 25cc. of water to 12.5 gms. of $Co(NO_3)_2 \cdot 6H_2O$ and 20 gms. of $NaNO_2$.

The sample is then decanted free of the reagent and washed thoroughly with water by further decantation and dried. The grains are now ready for microscopic examination.

Uncovered, thin sections and polished rock surfaces are treated with hydrofluoric acid in a special lead box. After this treatment they are stained and dried and, if required for permanent record, covered with a cover glass. It has been found that the dye changes slightly with time if exposed to the air and is easily removed by abrasion.

ACKNOWLEDGEMENT

The authors are indebted to Professor Edwin T. Hodge, of the University of Oregon, under whose direction the method was developed.

THE QUANTITATIVE OPTICAL DETERMINATION OF SODIUM AND POTASSIUM CHLORIDES.

CHESTER B. SLAWSON, *University of Michigan*

In the analysis of the average igneous rock the alkalis generally represent less than ten per cent of the total constituents that are present. The standard methods for their determination all call for the separation and weighing of the alkalis in the form of the combined chlorides. Potassium is then generally separated and determined gravimetrically while sodium is obtained by difference. In a great many cases the total aklalis are present in such small amounts that it is impossible to accurately separate them so they are often reported as Na_2O+K_2O. The following method for the determination of sodium and potassium is based upon the the microscopic determination of the index of refraction of a fusion of the combined chlorides and is, therefore, equally well adapted to either large or small precipitates. The maximum error should be less than 2 per cent and in many cases should be well under one per cent. In an analysis in which the total alkalis represent 10 per cent of the total constituents this would give an error of 0.2 per cent on the whole sample, and in cases where the alkalis represent 3 per cent or less the error would be under 0.06 per cent on the whole sample.

The index of refraction of potassium chloride for the *D* line is 1.490 and of sodium 1.544. If a mixture of these chlorides be fused and cooled so as to give a solid solution the index of refraction of the material would lie somewhere between these values. The percentage of sodium chloride would be $n-1.490/1.544-1.490$. In this case the accuracy of the determination would depend upon the accuracy of the determination of the index of refraction. If the index of refraction be determined to the third decimal place the accuracy of the determination of potassium and sodium chlorides would be 2 per cent. This condition cannot exist, however, because of the formation of a series of double salts with the general formula $x\mathrm{KCl}\cdot y\mathrm{NaCl}$.

It was also found impossible to produce a glass because the melts could not be quenched quickly enough even when they were taken directly from the blast lamp and poured into amyl alcohol.

Kurnakow and Zemezuznyj[1] have studied the fusion curves of of the alkali halogens and published the curve reproduced in Fig.1. They found that molten KCl and molten NaCl were miscible in all proportions. The freezing point of these mixtures is represented by the curve ABC. In studying the rate of cooling of the solidified melts, from the freezing point to room temperature, they found that those mixtures lying in the range of 25.0–75.0 per cent

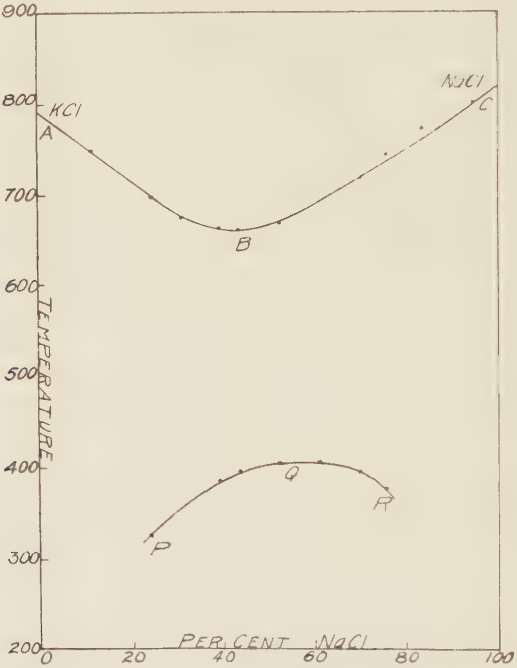

FIG. 1.

NaCl show a sharp break in the cooling curve near 400°C. The curve PQR shows the temperature at which this break takes place for the various mixtures. At this point the temperature remains constant for a considerable period of time and this was interpreted as being due to the breaking down of the mixed crystals of chlorides with the evolution of heat. E. Janecke[2] has extended this curve by the use of dilatometric methods to cover the complete range of possible mixtures. G. Tammann[3] also states that a continuous series of mixed crystals exists above 500°C and that the phenomena observed when the mixed crystals are cooled must be attributed to the separation of the components. According to the authorities cited above no evidence of the existence of definite double salts was found. The terms solid solution, isomorphous mixture, and mixed crystals were used interchangeably to describe a condition similiar to that existing in the plagioclase feldspars.

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[1] *Z. anorg. Chem.*, **52,** 186 (1907).

[2] *Z. physik. Chem.*, **90,** 296 (1915).

The microscopic examination of a series of melts in this laboratory showed that KCl and NaCl do not form a continuous series similar to the plagioclase feldspars but that double salts with the general formula $x\text{KCl}\cdot y\text{NaCl}$ were formed. With the exception of those cases in which KCl and NaCl are present in definite molecular proportions corresponding to a possible double salt, two distinct components separate from a fusion. The following double salts with the corresponding indices of refraction were determined. Above and below this series, double salts of the two chlorides[4] exist but the resulting compounds approach each other so closely in their composition that it is impossible to determine them definitely. The indices of refraction of these compounds would vary by less then 0.001 and the accuracy of the optical method employed is not greater than this variation. There is also some evidence of solid solution near the end members of the series but this could not be definitely established.

	N	% KCl	% NaCl
$7\text{KCl}\cdot 2\text{NaCl}$	1.500	81.70	18.30
$5\text{KCl}\cdot 2\text{NaCl}$	1.503	76.13	23.87
$3\text{KCl}\cdot 2\text{NaCl}$	1.5085	65.68	34.32
$\text{KCl}\cdot \text{NaCl}$	1.514	56.04	43.96
$3\text{KCl}\cdot 4\text{NaCl}$	1.518	48.89	51.11
$2\text{KCl}\cdot 3\text{NaCl}$	1.519	45.95	54.05
$\text{KCl}\cdot 2\text{NaCl}$	1.523	38.94	61.06
$\text{KCl}\cdot 3\text{NaCl}$	1.528	29.83	70.17
$\text{KCl}\cdot 5\text{NaCl}$	1.533	20.33	79.67
$\text{KCl}\cdot 7\text{NaCl}$	1.536	15.42	84.58

These double salts were determined by mixing index liquids upon the microscopic slide until they matched the salt (using the Becke method and Na light) and then immediately determining the index of refraction of the liquid by inverting the slide on the Abbe refractometer. This reduces the error due to temperature variations to a minimum. Because of the isotropic nature of the melts and the perfect cubical cleavage which gives vertical contacts between the liquid and the substance it is possible to determine the index of refraction to 0.0007.

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[3] *Nachr. Ges. Wiss., Göttingen,* 422 (1919).

[4] Nearly conclusive evidence of the existence of $\text{KCl}\cdot 9\text{NaCl}$ was found.

An X-ray diffraction pattern taken by Dr. Ramsdell of this laboratory confirmed the work of Kurnakow and others[5] and established the fact that the double salts break down into their components upon cooling. Therefore the index of refraction of a double salt as recorded was not determined upon the actual compound but was the additive index[6] of intimate mixtures of KCl and NaCl. This break down in the structure is submicroscopic and no evidence of it is observed under the microscope.

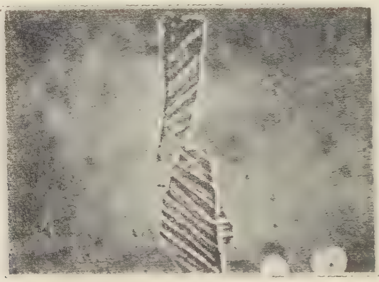

Fig. 2. (x115)

The light lines in the photograph are the Becke lines at the contact of the two components. The position of the Becke line does not mark the exact contact but lies to one side.

The use of the double salts in the determination of the amounts of KCl and NaCl may best be shown by an example. Fig. 2 is a photomicrograph of a solidified melt which contains 65 per cent NaCl. It is evident from the photograph that two components are present, one of which has a slightly higher index of refraction than the other. From Fig. 3 it may seen that in a melt of this composition two compounds, $KCl\cdot 2NaCl$ and $KCl\cdot 3NaCl$, should develop and their respective indices of refraction should be 1.523 and 1.528. Theoretically there should be 57 per cent of $KCl\cdot 2NaCl$ present. In Fig. 2 it is evident that the material with the lower index of refraction is present in slightly greater amounts then the other. If we were to estimate from Fig. 2 that the two components, KCl·2NaCl and KCl·3NaCl, were present in equal proportions, the calculated percentage of NaCl in the melt would be 65.6 %. If the estimate of the proportions was 2:1 the calculated percentage of NaCl would be 64.1 %. This shows that a relatively large error in the estimation of the proportions of the double salts yields however a small error in the calculated value of the amount of NaCl present. In certain ranges, such as 51.1–54.1 % of NaCl the degree of accuracy is much greater. In practice it is not necessary to determine very accurately the index of refraction because any value lying between the indices of refraction of two adjacent salts (Fig. 3) determines what double salts are present.

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[5] *Op. cit.*

[6] Posnjak, E and Merwin, H. E., *Am. J. Sc.*, 47, 321 (1919).

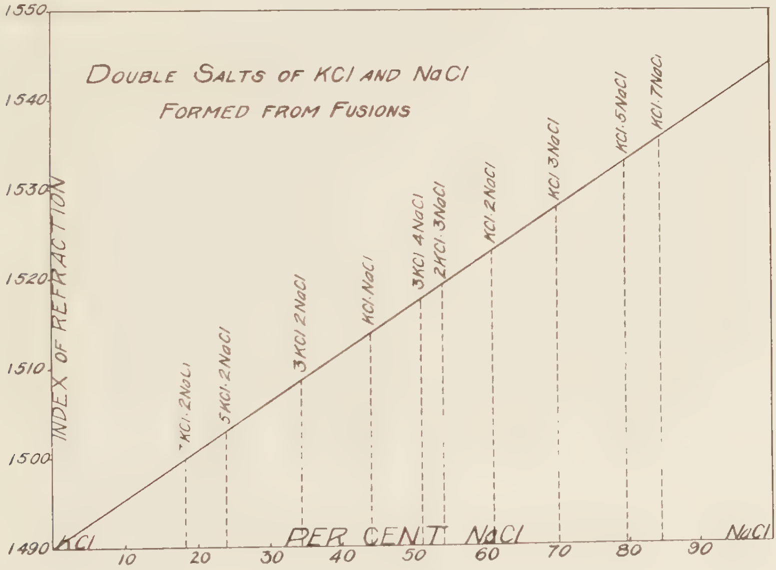

Fig. 3.

Near the end members of the series the situation is somewhat more difficult because it is necessary to accurately determine the index of refraction. Two components may be present but their compositions, and therefore their indices, are so close together that the above method cannot be applied. In this range the accuracy of the determination of KCl and NaCl depends upon the accuracy of the determination of the index of refraction. If an index intermediate between the two components is determined and taken as the average value of the index of the melt the error in all cases will be less than 2 per cent.

In working with very small precipitates the errors of technique are greater than those of the microscopic determination. One of the chief sources of error is the tendency of the salt to decrepitate while drying the precipitate before fusing. This is due to the occluded solvent and is common to all methods for the determination of potassium and sodium as chlorides. The small precipitates are best fused in a small platinum cone similar to the platinum filter cones. The shrinkage of the melt upon cooling loosens it from the side of the cone and it readily drops out. It is well to crush and grind this globule and refuse it in order to insure complete mixing. The precipitate should not be heated above the fusion point because of the tendency of the chlorides to volatilize.

While this method leaves much to be desired it is a beginning in the application of petrographic methods to chemical quantitative microscopic determinations. It has been used satisfactorily as a laboratory exercise in one of our classes. In this class work only intermediate mixtures were used because of the difficulty in working near the end members of the series.

In the determination of potassium and sodium the petrographic method must compete with well established and accurate chemical methods so its practicability is confined to small precipitates. It should be possible, however, to apply similar optical methods to some of the more difficult quantitative separations such as the separation of strontium from calcium.

MINERAL DETERMINATION BY ABSORPTION SPECTRA. I.

Edgar T. Wherry, *Washington, D. C.*

With the perfecting of the immersion method for measuring the refractive indices of crystals, other means of mineral identification have been more or less relegated to the background, but their existence should not be forgotten entirely, for problems occasionally arise which they may aid in solving. Several years ago I published[1] a comprehensive study of the absorption spectra of minerals, as seen with the microspectroscope. That paper has long been out of print, but every now and then requests for certain information along this line are received, so the republication of part of the data included in it, together with some obtained from other sources, seems worth while. The method of presentation adopted is directed toward the identification of transparent or translucent, more or less distinctly colored, minerals.

The apparatus used in identifying minerals by their absorption spectra consists of a microscope eyepiece containing a direct-vision spectroscope. Of these there are two main types, one with relatively small dispersion, which yields the more intense effects, but does not permit of wave-length measurement, the other with greater dispersion, yielding fainter bands but providing for accurate measurement of their wave-lengths. As pointed out by Keeley,[2] the former type is well adapted to preliminary examination, and in many cases will produce such characteristic absorption phenomena that no further observations are needed; for final decision, however, the determination of the exact positions of the bands by means of the more elaborate instrument is desirable.

In the majority of cases, far more striking absorption spectra are obtained when the mineral is viewed by scattered instead of directly transmitted light. The stage of the microscope is accordingly best covered completely by a dull black card, and the most brilliant source of white light available adjusted so that a beam is concentrated on the side of the object under observation, by means of a condensing lens system or a parabolic reflector attached to the microscope objective. When minute grains are to be studied, they are first centered and brought into focus while the prism is out, and the latter is then inserted; if irregularities in the grain produce distortions in the spectrum, the microscope tube can be raised slightly, so that sharpness of focus is lessened. The field of the spectroscope should be narrowed, transversely to the spectrum, so that only the area of the grain itself is covered; and the slit should be reduced to the minimum opening through which light can be seen, to make the absorption bands as sharp a possible. If a wave-length scale is attached, this should be adjusted by bringing 589mμ into coincidence with the yellow line seen when a sodium flame is viewed.

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[1] The microspectroscope in mineralogy. *Smiths. Misc. Coll.*, **65**, no. 5, 16 pp., 1915.

[2] Microspectroscopic observations. *Proc. Acad. Nat. Sci. Phila.*, **1911**, 106–116.

Minerals containing no constituents capable of producing well-marked absorption bands yield a continuous spectrum, which is visible from wave-length 700, at the red end, to 400, at the violet. When a chemical element which absorbs certain wave-lengths much more strongly than adjacent ones is present, however, one or more dark bands will be seen in the midst of this spectrum, and the positions of these are in many cases so characteristic that they can be used for identification both of the element and of the mineral. Absorption in narrow bands or lines is shown by certain of the rare-earth metals and by uranium, in broader bands by chromium, cobalt, copper, iron, manganese, vanadium, and occasionally other.

PART 1. ABSORPTION SPECTRA CONSISTING OF NARROW BANDS

Strongest band or group of bands in the yellow, a fairly strong one in the green, and many weaker ones at intervals throughout......Cerium earths, group 1.
Strongest band in the green-yellow, a fairly strong one in the green, and a few weaker ones elsewhere........................Yttrium earths, group 2.
Strongest band in the red, a fairly strong one in the orange-yellow, and many weaker ones at intervals throughout..................Uranous uranium, group 3.
Strongest band in the green-blue or the blue-green, and a few others, chiefly toward the violet end..............................Uranyl uranium, group 4.

GROUP 1. THE CERIUM EARTHS, NEODYMIUM AND PRASEODYMIUM

The average wave-lengths of the principal absorption bands shown under the microspectroscope by minerals containing these elements will be listed first; the bands actually vary distinctly in wave-length and intensity from one compound to another. The minerals will then be discussed, class by class.

Spectrum-zone	red	orange		yellow		green			blue		b-v.
Wave-length.	675	620	595	**580**	**570**	530	520	510	485	470	445
Element.....	Nd	Nd	Pr	Nd	Nd	Nd	Nd	Nd	Pr	Pr	Pr

Fluocerite, (tysonite of Dana), (Ce, X)F_3

675	(623)	**595**	...	...	580–570	(532)	522	(513)	(485)	W.
...	...	590 ‖	587–586 ‖	**584–575** ‖	573–568	...	...	...	...	K.

The most characteristic features of the spectrum of the specimen of this mineral I examined, as tabulated in the line marked W are the intensity of the bands centering at 675 and 595, and the relative weakness of the group of coalesced bands extending from 580 to 570. The one studied by Keeley[3] as to the details of the bands in the yellow spectrum-zone, gave the data tabulated on the line marked K, and was evidently dissimilar in composition; its striking features consist of intense absorption at 584–575, and brilliant transmission at 586–584 and 575–573 (indicated by ‖).

Bastnaesite, (Ce, X)F(CO_3)

675	(623)	(590)	**579** ‖	**569**	(532)	522	(511)	(485)	W.

This mineral is characterized by the weakness of the lines due to praseodymium, and the intensity of the bands at 579 and 569 with transmission between them at 576–572.

Parisite, Ca(Ce, X)$_2F_2(CO_3)_3$

	675	**623**		**590–570**			533	...	**522**	**512**	485	(470)	(445)	W.
	. .	. .	581–576 ‖		575–568		...	...	...	...	...	...	...	K.
ω	677	630	**583**	579	575	...	533	529	**523**	511	483	471	445	B.
ε	**677**	650	583	**580**	575	**571**	533	**529**	521	(512)	483	471	445	B.

Like many others in this group, parisite evidently varies in composition and correspondingly in absorption spectrum, from one specimen to another. Notable features of the one I studied are the intensity of the bands at 623 and 512, and the practical coalescence of the three bands in the yellow spectrum-zone, which in most rare earth minerals are rather distinctly separated. Keeley[3] found this coalescence to be not quite complete, although the transmission at 576–575 is dim. Becquerel[4] had previously studied the absorption spectrum of this species, from the viewpoint of the differences in the directions of the ordinary and extraordinary indices; but he used a large spectroscope, and was able to detect many more lines than could be found by the present method, so only the more significant of his wave-lengths are here given.

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[3] Notes on absorption spectra of certain minerals. *Festschrift Victor Goldschmidt*, **1928**, 170–171 and pl. 7.

[4] Researches on the variations of absorption spectra in crystals. *Ann. chim. phys.*, [6] **14**, 170–257, 1888; especially page 193.

Ankylite, $Sr(Ce, X)_2(OH)_2(CO_3)_3$

(675)	590	**580–575**	(570)	521	(512)	W.
...	...	582–576	...	...	...	K.

In my previous paper, ankylite was reported to show no absorption spectrum, but the specimen was evidently wrongly labelled for one was found subsequently which yielded that here recorded The most striking feature is the presence of a single strong band in the yellow, and the weakness of the one at 570 which is usually very intense in cerium-earth minerals.

Cordylite, $Ba(Ce, X)_2F_2(CO_3)_3$

(675)	(590)	**583–579**	(575)	(533)	521	512	(485)	470	W.
...	...	582–576	...	...	...	...	...	...	K.

Keeley found no difference between the absorption in the yellow of ankylite and cordylite, but they differ in the intensities of the lines in other spectrum zones.

Lanthanite, $(Ce, X)_2(CO_3)_3 \cdot 9H_2O$

(675)	(620)	(590)	...	**580–578‖572–568**	(532)	**520**	**510**	(485)	(470)	(445)	W.
...	...	(586–578)		578–574‖**572–568**	...	...	...	...	...	...	K.

This mineral is often assigned the formula of a pure lanthanum carbonate, but the analyses on which this is based give no evidence of trustworthiness, and it seems more likely to be analogous in rare-earth constituents to the other minerals under discussion. Characteristic features are the weakness of the band centering at 590, and the brilliant transmission in the yellow, at about 573.

Calcite, neodymian, $(Ca, X)(CO_3)$

582 (525) W.

That the violet calcite from Joplin, Missouri, owes its color to the presence of neodymium has been pointed out elsewhere.[5] In this case side-illumination does not produce very good results, but on transmitting white light through a cleavage piece 3 or 4 cm. thick two distinct absorption lines are visible.

Strontianite, neodymian, $(Sr, X)(CO_3)$

589 **585** **580** (578) 574 (571) **568** B.

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[5] Neodymium as the cause of the red-violet color in certain minerals. *J. Wash. Acad. Sci.*, 7, 143–146, 1917.

Greenish strontianite was discovered by Becquerel (*op. cit.*, p. 230) to show this absorption spectrum, although it is difficult to obtain any lines from this mineral by the microspectroscope.

Scheelite, neodymian, (Ca, X)(WO_4)

ω	595	593	589	587	585	580	575	533	529	527	B.
ε	. .	593	589	587	**585**	580	**575**	532	528	...	B.

In specimens of this mineral from Traversella, Becquerel (*op. cit.*, p. 191) observed the lines tabulated. The microspectroscope shows only traces of the strongest.

Monazite, (Ce, X)(PO_4)

	675	622	**590**	—	—	—		**570**	(532)	**523**	512	485	...	W.
			586−582	‖	580−576	‖	574−568		...	...	...	...	...	K.
α	682	627	592	584	580	575	574	**572**	**527**	**523**	513	484	475	B.
β	682	627	592	584	580	575	**574**	**572**	527	**522**	513	**484**	475	B.
γ	682	627	592	**584**	580	**575**	574	**572**	527	**522**	513	...	...	B.

This mineral, the commonest rare earth phosphate, yields a very intense absorption spectrum, and can readily be identified by this means even when present as minute grains in a sand. Its bands in the yellow region are so intense as to tend to coalesce, to an extent differing with the source of the material. The specimens studied by Keeley showed rather evenly spaced light and dark bands. That examined by Becquerel (*op. cit.*, p. 227) with the large spectroscope gave rather different wave-lengths for several bands from that available to me.

Britholite, (Ce, X)+(PO_4)+(SiO_4)

(675)	(590)	**588−578**	...	530	(520)	(512)	(485)	W.
..	..	589−576	**570−568**	...	...	...	...	K.

This mineral, supposed to be a silicato-phosphate, shows much weaker absorption than monazite, but like the latter varies from one specimen to another, as the stronger band observed by Keeley did not show up in my specimen at all.

Rhabdophanite, (Ce, X)(PO_4) · H_2O

675	622	**595**		— — —	**570**	533	**524**	512	485	(470)	(445)	W.
..	...	(586−581)		**581−578**	(578−568)	...	...	...	...	...	...	K.
...	625	595	592	**580**	(576−571)	**526**	524	(512)	(484)	(477)	...	B.

As might have been expected, this mineral shows nearly the same spectrum as its anhydrous representative monazite, although the bands in the yellow are more completely coalesced, with maximum absorption near 580. (See Becquerel, *op. cit.*, p. 228.)

Churchite, $HCa(Ce, X)_3(PO_4)_4 \cdot 7H_2O$
(675) (620) **590** || **578** (535) 524 (510) (485) W.

There can be no doubt as to the distinctness of this from the preceding mineral, as all its bands are weaker, and the two in the yellow are clearly separated, with transmission at 588–581.

Pyrochlore, Na-Ca-(Ce,X)-Ti columbate
588–578 (525) W.

The single strong band in the yellow is characteristic of this mineral. The corresponding tantalate, microlite, differs in that its bands, while identical in position, are much weaker.

Samarskite, Fe-U-(Ce, X) columbate
(585) (525) W.

In my earlier article this compound was reported to show no absorption spectrum, butmore translucent material was subsequently found to exhibit faint Nd bands. The same effect is shown by eschynite, which differs in containing also titanium, but the remainder of the columbates seem too opaque for study in this manner.

Cerite, $(Ce, X)_2(SiO_3)_3 \cdot H_2O$ (?)
(675) (620) **590–570** (533) (525) (512) (485) W.

The bands of this, the silicate with the highest known cerium earth content, are rather distinctive, although all except the broad one in the yellow are faint.

Freyalite, $(Th, Ce, X)(SiO_4) \cdot H_2O$ (?)
(675) (590) **585** || **575** **530** (525) (512) (485) W.

The three strong bands, with transmission in the yellow at 582–578, are characteristic of this little known mineral.

Rinkite, Na-Ca-(Ce, X) titanosilicate
590–582||578–568 K.

This rare mineral has been foundby Keeley (*loc. cit.*) to show two broad absorption bands in the yellow spectrum zone, the gap between them lying at 582–578, a different position from that of any other member of the division.

Other silicates

A specimen in the National Museum collection labelled rowlandite, supposedly $Y_4(SiO_4)_3$, yielded bands corresponding to moderate amounts of Nd, with a rather intense one at 585–575; its composition evidently needs further investigation.

The remaining cerium-earth silicates tried, comprising mosandrite, sphene, tritomite, and woehlerite, show faintly the two Nd lines at 585 and 525. In addition, Becquerel (*op. cit.*, p. 229) found in leucophanite strong lines at 589 and 587.

In concluding the discussion of the cerium-earth minerals, it should be noted that secondary uranium compounds derived from primary ones containing these earths may show in addition to the uranium bands one or more of those due to neodymium.

Group 2. The yttrium earths, samarium and erbium.

The approximate positions of the bands shown under the microspectroscope by minerals containing these elements are as before tabulated first. Four of them are obviously due to the metals indicated, but the lists of absorption spectra of known rare earth metals do not include a band in the orange spectrum zone, in the neighborhood of 605, so the source of this line is indeterminate.

Spectrum-zone	red	orange	yellow	green	blue
Wave-length.....	645	605	**555**	522	485
Element........	Er	?	Sm	Er	Sm

Fluorite, yttrian, $(Ca, X)F_2$

(650) (605) 555 (522) W.

The brownish-green fluorite from Amelia, Virginia, which is known as chlorophane because of its green thermoluminescence, shows bands indicating the presence of traces of yttrium earths.

Xenotimite, $(Y, X)(PO_4)$

	(660)	...	...	**645**	**605**	**555**	(545)	...	...	...	522	...	(485)	W.
ω	**657**	**653**	**651**	644	...	552	**546**	...	539	**524**	**521**	492	**489**	B.
ε	658	655	652	**644**	...	550	**545**	**542**	**539**	524	521	**494**	488	B.

The spectrum of this mineral is intense and highly diagnostic. Becquerel (*op. cit.*, p. 194) observed lines due to several other metals than those here listed.

Fergusonite, $(Y, X)(CbO_4)$ and related minerals.

(555) (522) W.

Most of the columbate minerals are too opaque to show any absorption spectrum, but fergusonite, inclusive of sipylite, (which is evidently the same, the analysis being untrustworthy) yields the faint bands tabulated.

Yttrotantalite, $HCa(Y, X)_2(TaO_4)_4$ (?)

(650) (600) (555) **522** W.

The absorption band at 522 is so strong in this mineral, as well as in the related if not identical risoerite, that its identification can be based on this feature.

Yttrialite, $(Y, X)_2Si_2O_7$

(645) (600) (555) (522) (485) W.

The bands in this compound are fainter than would be expected. Rowlandite, which is supposed to be related, shows the same bands together with a strong one at 580 which appears to be due to neodymium, but the specimen studied may not have been correctly labelled. Faint yttrium-earth bands are also shown by some minerals characterized particularly by cerium-earths, such as monazite.

GROUP 3. URANOUS URANIUM.

Spectrum-zone	red		orange		yel.		green		blue	
Wave-lengths	686	660	**652**	618	589	561	539	511	482	458

Zircon, uranoan, $(Zr, U^{\prime\prime\prime\prime})(SiO_4)$

	687	...	650	615	586	561	538	508	478	455	K.
	685	(660)	**651**	618	**588**	560	537	**512**	483	(460)	W.
ω	691	658	**654**	...	590	562	538	512	483	...	B.
ϵ	682	659	652	621	589	..	543	...	...	..	B.
	685	661	**651**	(619)	591	(560)	**539**	(511)	(483)	...	K. & H

The only mineral in which these bands have thus far been observed is transparent zircon; they are most intense in bluish colored types.[6] The wave-lengths differ slightly from one specimen to another, as brought out by tabulating the values reported by Keeley (paper of 1911, p. 107), the writer, (*op. cit.*, p. 9), Becquerel (*op. cit.*, p. 196, and[7]) and Kraus and Holden.[8] They are still different in uranous salts, obtained by reducing uranyl compounds with zinc and an acid, but not sufficiently so to raise any question as to their being due to this form of the element in the mineral.

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[6] They are said to have first been noted by Sorby, *Phil. Mag.*, **39**, 35, 1860.

GROUP 4. URANYL URANIUM.

Spectrum-zone	yel.		green			blue		v-b.
Wave-lengths	550	535	515	**500**	485	465	455	445

This spectrum, characterized by several nearly equally spaced absorption bands in the green and blue, is shown by the more transparent of the secondary uranium minerals, although so many earthy ones do not give it, that its failure to appear can not be considered as proof of the absence of the element.

Liebigite, $CaCO_3 + (UO_2)(CO_3) + H_2O$

(535) (515) 495 (480) **463** 455 (440) W.

This is the only mineral observed in which the band in the blue, at 465–461, is most intense, this feature being thus diagnostic. Material labelled uranothallite gives the same bands, confirming the suspected identity of the two.

Voglite, $(Ca, Cu)(CO_3) + (UO_2)(CO_3) + H_2O$

504 **488** 472 458 **447** W.

The presence of a small amount of copper changes the spectrum markedly from that of the related compound, next preceding. The lines here tabulated are similar to those of torbernite, but otherwise more or less diagnostic.

Johannite, $Cu(UO_2)(OH)_2(SO_4)_3 \cdot 3H_2O$

497 **479** (466) (450) W.

This mineral is interpreted as including gilpinite, uranochalcite, and voglianite. Its spectrum is unique in containing but two really well-marked bands, in blue-green and blue.

Autunite, $Ca(UO_2)_2(PO_4)_2 \cdot 8 \pm H_2O$

(550)	(532)	515	**499**	484	(468)	(455)	**445**	W.
...	...	...	504	**487**	472	457	445	R.

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[7] Relations between absorption of light and phosphorescence in uranium compounds. *Compt. rend.*, **101,** 1252–1256, 1885.

[8] Gems and Gem Materials, p. 60, 1925.

The second set of wave-lengths tabulated was that obtained by Rinne.[9] The prominence of the bands in the green, blue-green, and violet-blue is diagnostic; the most intense shown by my specimens was the second noted, running from about 501 to 497.

Uranospinite, $Ca(UO_2)_2(AsO_4)_2 \cdot 8 \pm H_2O$

(530)	**495**	482	(467)	(455)	(440)	W.

This mineral can be distinguished from the other members of the group by the presence of but a single intense band in the blue-green, at wave-lengths 497–493.

Uranocircite, $Ba(UO_2)_2(PO_4)_2 \cdot 8 \pm H_2O$

552	535	515	495	(485)	(470)	(455)	448	W.

None of the bands in this mineral are sufficiently intense to indicate in bold-face type, but the two in the yellow and green are better marked than in any other mineral of the group.

Torbernite, $Cu(UO_2)_2(PO_4)_2 \cdot 8 \pm H_2O$

503	...	**487**	470	458	**445**	W.
503	(498)	**486**	471	456	**444**	R.

The absence of bands in the yellow and yellow-green, but the presence of three strong ones elsewhere, is diagnostic of this species (see Rinne[10]).

Zeunerite, $Cu(UO_2)_2(AsO_4)_2 \cdot 8 \pm H_2O$

505	**489**	472	459	**448**	W.

The diagnostic features of this spectrum are the relative weakness of the band in the green and the intensity of the one in the violet blue at a slightly different point from its relative, next preceding, namely at 450–446.

Commercial uranium glass exhibits all of the absorption bands shown by any of the minerals containing uranyl, with an additional one in the orange at 595. Those in the blue-violet, however, are so broad as to coalesce, from about 455 to 435, or to the end of the visible spectrum. Uranyl salts behave similarly, although the details vary considerably with the composition.

(*To be concluded*)

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[9] Autunite and its dehydration product (metautunite). *Centr. Min. Geol.*, **1901,** 709–713.

[10] Torbernite and its dehydration product (metatorbernite). *Centr. Min. Geol.*, **1901,** 618–626; especially p. 622.

NOTES AND NEWS

NEW AND INTERESTING MINERALS FROM CENTRAL NEW JERSEY

A. C. HAWKINS, *Rutgers University*

The continued activity of quarries in the basalts of central New Jersey has brought to light a number of interesting occurrences during the last two or three years. In addition to this, old localities also have offered interesting material.

At the Arlington copper mine, north of the city of Newark, the writer has recently discovered covellite. This is in the form of small, bright blue plates characteristic of the mineral, on the surface of a massive gray shale stained with copper compounds. Covellite is new to New Jersey, so far as records of discoveries are concerned.

Barite, somewhat similar to that more recently found at Paterson, was formerly worked in prospect pits at Glenmoore, south of Hopewell, in Mercer County. The locality is marked on the Trenton Folio geological sheet of the United States Geological Survey. It is associated with an intrusion of diabase, and is locally brecciated by the extensive crushing due to the faults in the vicinity. Large fragments of white, cleavable barite have been used to fill up the roadbed and are scattered about in the vicinity. Recently an excellent crystallized specimen from this locality was discovered in the collection of the Rutgers University museum, the specimen having been given by the late Mr. F. A. Canfield. The specimen measures 15×12×7 cm. and is covered with slightly yellowish tabular crystals which are 2 to 4 cm. across and 2 to 3 mm. thick. The largest face is the base *c*, with narrow brachypinacoid *b*, brachydome *o*, macrodomes *d* and *l*, and small faces of the prism *m*. The crystals are grouped in parallel position.

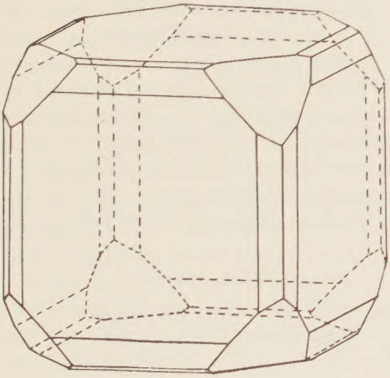

FIG. 1. Native Copper from Bound Brook, N. J.

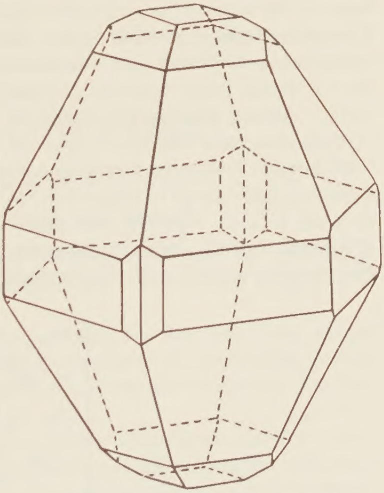

FIG. 2. Chalcocite from Bound Brook, N. J.

In the quarry of the Bound Brook Crushed Stone Company at Chimney Rock there are occasional specimens of calcite crystals which show interesting groupings. Most of the crystals are rhombohedral in habit, while some are scalenohedral. They are obtained at present from a large calcite vein which extends upward nearly vertically along the quarry wall, having filled the breccia in a fault which had a horizontal movement. Locally with and in the calcite there is crystalline bornite with chalcocite, one mass of which attained a thickness of 5 cm., and would make a good ore if there were enough of it. Native copper is also present in some abundance at times, plates of small size on the diabantite-coated joints of the basalt affording bright, attractive specimens. The largest plate of copper weighs 96 pounds, and is now in the Rutgers University museum, because it would not go through the crusher. Copper crystals 2 mm. in diameter obtained from the cavities of this specimen are simple dodecahedrons. Yet the most interesting and complicated copper crystals, obtained in 1928, came from a vein near the floor of the quarry. This vein was nearly horizontal, and occupied the junction between two flows of the basaltic lava. The vein was filled with crystalline prehnite and datolite, in which copper in small, untarnished sheets and crystals was locally abundant. In the cavities in this vein there were small black chalcocite crystals, which are evidently secondary, as is also the bornite in the calcite vein above referred to. Figure 1 shows the habit of the copper crystals. Many are simple cubes or cubo-octahedrons with sharp angles, while others show the tetrahexahedron *f*(310). Some crystals are twinned on the octahedron, and an especially good one, slightly more than 1 mm. in size, extremely flattened on *o*, like the galena twins from Freiberg, was measured on the two-circle goniometer. It proved to show large faces of the octahedron, and also relatively large ones of hexoctahedron (245). This latter form is new for copper; although it is a simple form in a prominent zone, and should have been observed occasionally on isometric crystals, so far the writer has found only one reference to it, on pyrite from Cornwall, Pennsylvania.[1] Among minerals it is therefore a form of rare occurrence. The chalcocite crystals associated with the copper are of interest because many of them are entirely simple. Others are twinned on *m* as is usual for the species. Figure 2 shows a typical simple crystal of chalcocite. It shows the unit pyramid *p* and the obtuse pyramid *v* (112), with the unit prism *m*, brachypinacoid *b*, and brachydome *d*. The base *c* is small. Its most interesting feature is the appearance of two faces, well developed on a number of crystals, though small, of a new prism, (10·3·0), located

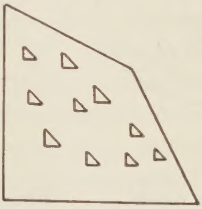

FIG. 3. Analcite from North Plainfield, N. J.
(One face with etch figures).

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[1] C. Travis, *Proc. Amer. Philos. Soc.*, XLV, p. 131, 1906.

not far from the position of the macropinacoid. Other prisms of this series have been observed, but this one appears to be new among observed crystal forms.

A renewal of activity in the basalt quarry of the Wilson Crushed Stone Company, now operated by Mr. C. Lewis, at North Plainfield, Somerset County, has recently supplied a large number of calcite crystals with a variety of interesting forms and groupings. The study of these will be undertaken in the future. Operations have also begun to expose the zone of weathered rock where occur in vertical seams some of the zeolites including orange colored stilbite, small plates of heulandite, and groups of small natrolite crystals, showing the simple prism with the unit pyramid. The latest addition to the list of minerals from this locality is analcite, occurring in glassy transparent crystals 2 mm. in size, on stilbite. The edges of the analcite crystals, which are of simple trapezohedral form, are all modified by a narrow vicinal trapezohedron evidently produced by etching, and the crystal faces all show interesting triangular etch figures, shown in Figure 3, which represents one face only.

In the basalt quarry at Millington (Lyons Station), Somerset County, microscopic transparent analcite crystals occur on the walls of a vertical joint plane. Their form is the trapezohedron, but they show, in addition to this, occasional square faces of the cube. The rarity of cube faces on this mineral makes the discovery interesting. Natrolite crystals from Millington are quite commonly grouped in pairs in parallel position, showing a notch on each side of the crystal along the length of the prism. The crystals look like those of scolecite from Iceland and elsewhere which are twinned (since they are monoclinic). Investigation of natrolite from a number of New Jersey localities shows that this sort of grouping is quite typical of natrolite from these localities.

Grateful acknowledgement is hereby made to Mr. H. P. Whitlock of the American Museum of Natural History for the use of the goniometer and aid in identifying crystal forms.

PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences, June 6, 1929.

A stated meeting of the Philadelphia Mineralogical Society was held on the above date with the president, Mr. Trudell, in the chair. Sixty persons were present including forty-three members.

Upon favorable recommendation of the council, the following were elected junior members: Messrs. Randall Heiligman, Harry Eissler, Jr., and Richard Archibald. Mr. Cienkowski proposed the names of Allen Bernheimer, Morris Naselaw, and Robert Williams.

Mr. Lester Strock addressed the society on "*The Spessartite Garnet of Avondale, Delaware County, Penna.*" The chemistry of garnets in general and the relation of their physical properties (specific gravity and index of refraction) to their composition was outlined, introductory to a detailed account of an investigation of the garnet of Avondale (Leiper's Quarry). An analysis showed the latter to consist of the following molecules: spessartite 61.6%, almandite 32.8%, and grossularite 5.6%.

Mr. Toothaker exhibited a rhyolitic obsidian from Oregon supposed to contain

1% Sn. Mr. Biernbaum distributed the prizes awarded to the boys at the Northeast High School for the best mineral exhibits shown there on May 23rd. Mr. Trudell described a brief visit to Ducktown, Tenn., and the Museum at the University of Alabama. Mr. Biernbaum exhibited prehnite and thaumasite recently collected at Paterson.

Samuel G. Gordon, *Secretary*

MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

Mineralogical Society, June 11. Dr. G. T. Prior, President, in the chair.

Mr. E. J. Wayland and Dr. L. J. Spencer: *Bismutotantalite, a new mineral from Uganda.* This was found in a pegmatite vein at Gamba Hill, about 35 miles N. W. of Entebbe. The large rough crystals, weighing up to a kilogram or more, are orthorhombic with a habit and axial ratios similar to those of columbite. Analyses made by Mr. W. O. R. Wynn at the Imperial Institute give the formula $Bi_2O_3 \cdot Ta_2O_5$, analogous to stibiotantalite ($Sb_2O_3 \cdot Ta_2O_5$).

Dr. L. Hawkes: *On a partially-fused quartz-felspar rock and on glomoro-granular texture.* In a partially melted granite fusion began at the quartz-felspar contacts. It is suggested that the temperature was raised above the eutectic point but not to the melting point of any of the constituent minerals, and that a granite of quartz-orthoclase-albite eutectic composition will melt completely in the dry state below 950°C. Coarse grained granites may exhibit a segregation of quartz and felspar, revealed in section by monomineralic areas of several grains in anhedral intergrowth. The name 'glomoro-granular' is proposed for this texture which may result from the normal undistrubed crystallization of the magma.

Dr. P. Marshall: *The occurrence of a mineral hitherto unrecognized in the phonolites of Dunedin, New Zealand.* A mineral with low birefringence and low refractive index hitherto taken to be either nephelite or sodalite is shown to be distinct from these and to be nearer microsommite or davyne. It is usually allotriomorphic but also occurs as very small (0.15 mm.) hexagonal prisms. Analyses of HCl solution of phonolites containing this mineral to the exclusion of other soluble silicates, indicate that it is a sodium alumino-silicate loosely combined with sodium chloride. The mineral stains dark violet when treated with silver nitrate. The name proposed for the mineral is ameletite.

Dr. G. T. Prior: *The meteoric stone of Lake Brown, Western Australia.* The stone, weighing when found 4.75 kg., has been known since 1919. Chemical analysis and microscopic examination prove it to be an intermediate hypersthene-chondrite of Baroti type.

Mr. I. de Fináły and Dr. Sándor Koch: *Fülöppite, a new Hungarian mineral of the plagionite-semseyite group.* This was found at Nagybánya, Hungary, as small monoclinic crystals of the plagionite habit. Analysis shows it to be an acid member of the group with the formula $2PbS \cdot 3Sb_2S_3$. Associated with it is an acicular (probably orthorhombic) lead-antimony mineral with the composition $3PbS \cdot 4Sb_2S_3$, which is compared with the Bolivian keeleyite.

W. Campbell Smith, *General Secretary*